Decadal Survey Symposium

HyspIRI Decadal Survey Mission Development Status

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Francois Rogez, Stephen Ungar

Presented by Robert O. Green

February 11-12, 2009

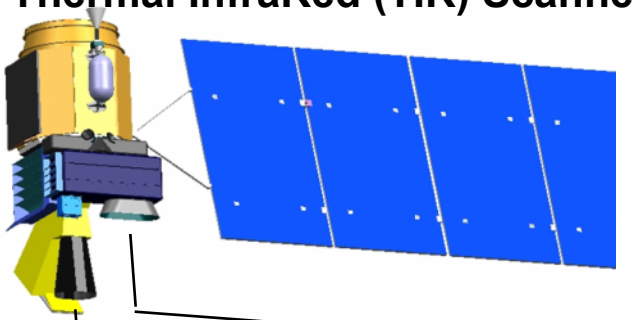
NASA Headquarters

NASA Decadal Survey HysplRI

Visible ShortWave InfraRed (VSWIR) Imaging Spectrometer

+

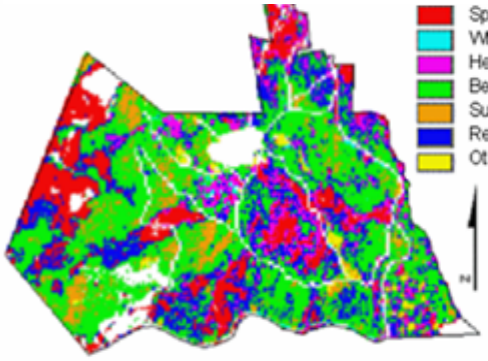
Multispectral Thermal InfraRed (TIR) Scanner

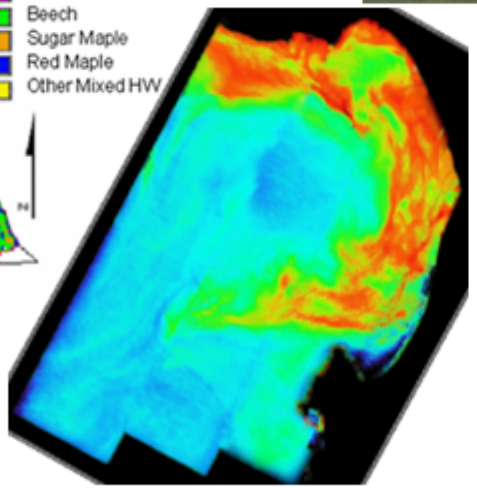


VSWIR: Plant Physiology and Function Types (PPFT)

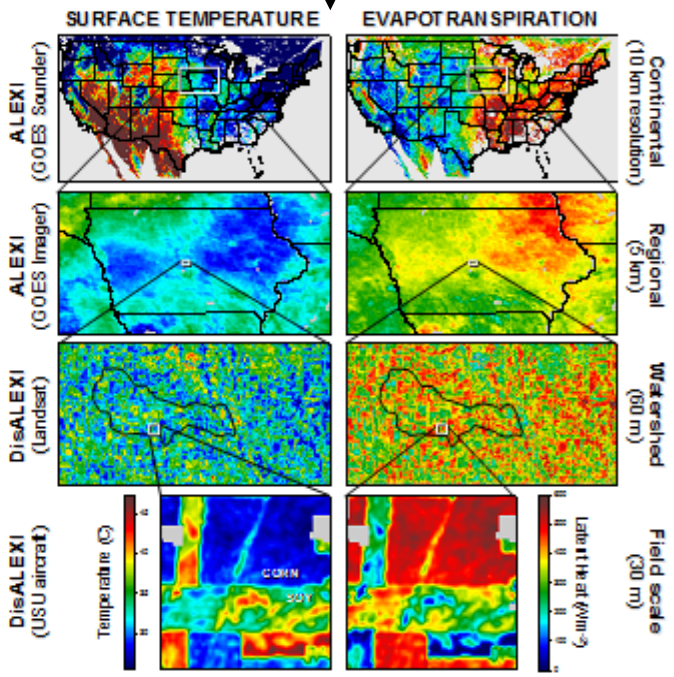
Multispectral TIR Scanner

Map of dominant tree species, Bartlett Forest, NH





Red tide algal bloom in Monterey Bay, CA



SV 1

HyspIRI NASA Decadal Survey Mission

Science

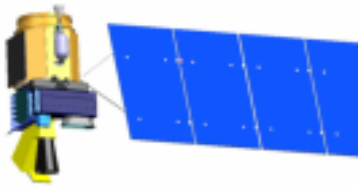
This mission provides global surface **reflectance,** surface **temperature** and surface **emissivity** at high spectral, spatial and temporal resolutions.

These data will be used to produce the first ever global measurements of ecosystem function and composition. Ecosystem function and composition are two of the three fundamental measurements which together with plant structure are required to understand terrestrial and coastal ecosystems.

The data will also be used to address key science questions related to volcanoes and wildfires, water use and availability, urbanization and land surface composition and change.

Architecture/structure

Three year mission, two Instruments on one spacecraft at 626 km 11 am sun sync orbit: (1) Imaging Spectrometer (VSWIR), (2)Thermal Infrared Multi-Spectral Imager (TIR)



VSWIR Science Measurement:
- 380 to 2500 nm in 10nm bands
- 60 m spatial resolution, 19 day revisit
- Global land and shallow water (<50m)

TIR Science Measurement:
- 8 Bands (7 bands between 7.5-12 µm & 1 band at 4 µm)
- 60 m spatial resolution, 5 day revisit
- Global land and shallow water
- Day and night imaging

FY09 Objectives and Deliverables

-HyspIRI workshop report and whitepaper with science traceability and baseline architecture

-HyspIRI Level 1 requirements (baseline and minimal)

-Mission implementation schedule and other required products for transition to Phase A

-Risk reduction and margin increase investments

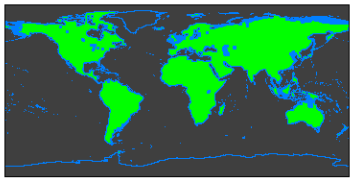
-August 2009 HyspIRI workshop

-Ready for MCR, Dec 2009

Mission Implementation Challenges

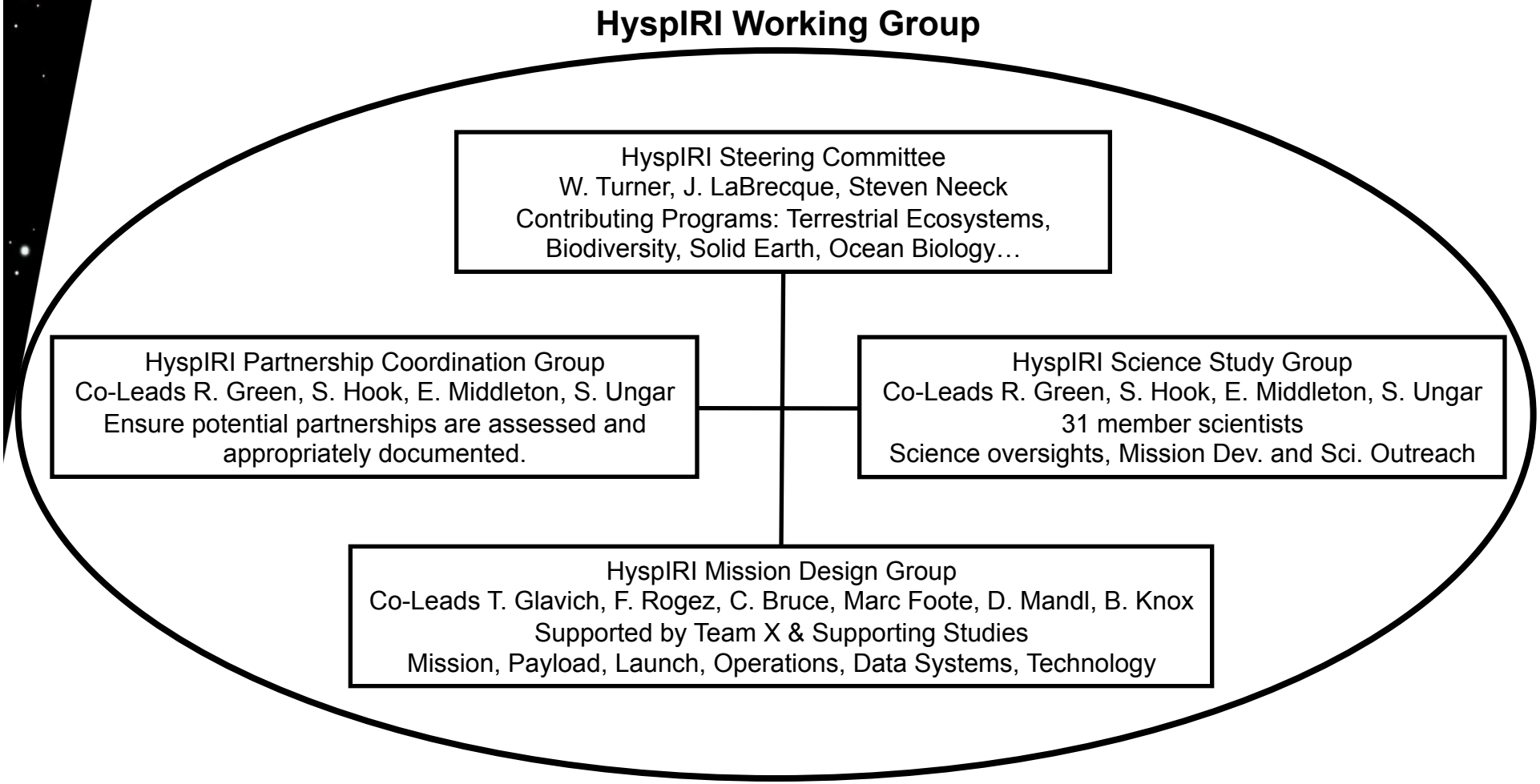
-HyspIRI is a high data rate mission. 740 Mbps dual polarization X-band downlink infrastructure will be needed at two polar ground stations.

-Data distribution and processing system for high volume products.



HyspIRI Execution Structure

The HyspIRI Working Group (HWG) will be managed by the HyspIRI Steering Committee that representatives of the principal HyspIRI science disciplines. The HWG will coordinate the activities of the Science Study Group, the Partnership Coordination Group and the Mission Design Group



SV 2

HyspIRI Mission Study Overview (1)

- Study Development Team
  - Science requirements
    - Initial baseline requirements were pulled from the NRC Decadal Survey.
    - These science requirements have been refined by the 2007 HyspIRI Science Working Groups and the 2008 HyspIRI Science Study Group (see back up for membership).
    - The HyspIRI Science Workshop community (>100 attendees) has further refined and vetted the requirements.
  - Technology Readiness
    - The HyspIRI instruments and mission have high relevant heritage, and correspondingly low risk, in conjunction with a modest cost.
    - There are some investments in incremental updates of current technology that are compelling for margin increase and risk reduction.
  - Partnership Interest
    - Downlink and ground science processing interest have come from Australia (Dr. Alex Held, CSIRO) and Canada (Dr. Allen Hollinger, CSA).
    - There is a possible launch and spacecraft partnership with India (Dr. VS Hedge).

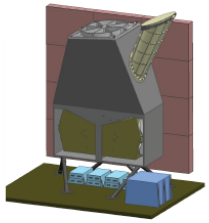
HyspIRI Mission Study Overview (2)

- Study Implementation Approach
  - Community Buy-in
    - The 2007 VSWIR and TIR Science Working Groups and the 2008 combined Science Study Group represent a large swath of HyspIRI-type science and applications investigators. These study group members have been communicating with their broader communities. Feedback has been excellent.
    - The 2008 HyspIRI Science Workshop included three days of science overviews and breakout sessions dealing with HyspIRI science with intense community involvement. An assessment following the workshop shows strong alignment between the HyspIRI Science Mission and the broad community represented by the more than 100 attendees of the workshop (see website: HyspIRI.jpl.nasa.gov)
  - Primary Science Issues
    - The Primary HyspIRI Science is well aligned with the call of the Decadal Survey as well as the requirements of broader science community.
      - 2007 SWGs, 2008 SSG, 2008 Workshop

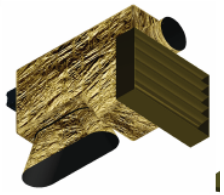
SV 2

HysplRI Mission Study Overview (3)

Consensus of the Science Study Groups



- *VSWIR Imaging Spectrometer Science Measurement*
  - 380 to 2500 nm in 10 nm sampling
  - 60 m spatial resolution, 19 days revisit
  - Global land and shallow water (<50 m)



- *TIR Thermal Infrared Multi-Spectral Science Measurement*
  - 8 Bands (7 bands between 7.5-12 µm & 1 band at 4 µm)
  - 60 m spatial resolution, 5 days revisit
  - Global land and shallow water
  - Day and night imaging

Taurus

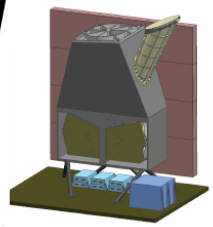
- *Mission*
  - Three years
  - ~626 km Orbit
  - 11 am Sun synchronous
  - Full terrestrial and shallow water regions
  - Spatially averaged for deep oceans and ice sheet
  - Zero loss compression of 3X (2X for TIR)
  - Rigorous on-orbit calibration (Lunar, Solar, Space, and Ground calibration)

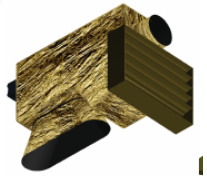
SV 4

HysplRI FY08 Study Team Results

- What was Delivered?
  - A set of refined science requirements with inputs from the 2007 and 2008 studies, including the October 2008 workshop, has been established. We will deliver these at the first mutually agreeable opportunity to NASA HQ.
  - Draft whitepaper, science traceability matrices, science questions.
  - 2007 Instrument and Mission reports were delivered.
  - 2008 Instrument and Mission reports to be **delivered Feb 12.**

- What possibilities were identified/eliminated?





  - A wide range of mission architecture and instrument architectures were examined. A common architecture for both instruments was adopted. Spatial resolution was set to 60 m and a direct broadcast capability was added for time critical events.
  - A high heritage/low risk approach has been adopted for both the HysplRI instruments and the mission.
  - **This high heritage approach meets all the HysplRI science requirements with margin.**

- How are results documented
  - Whitepaper, science traceability matrices, science questions, website
  - Detailed Team XI (Instrument study report)
  - Detailed Team XM (Mission study report)

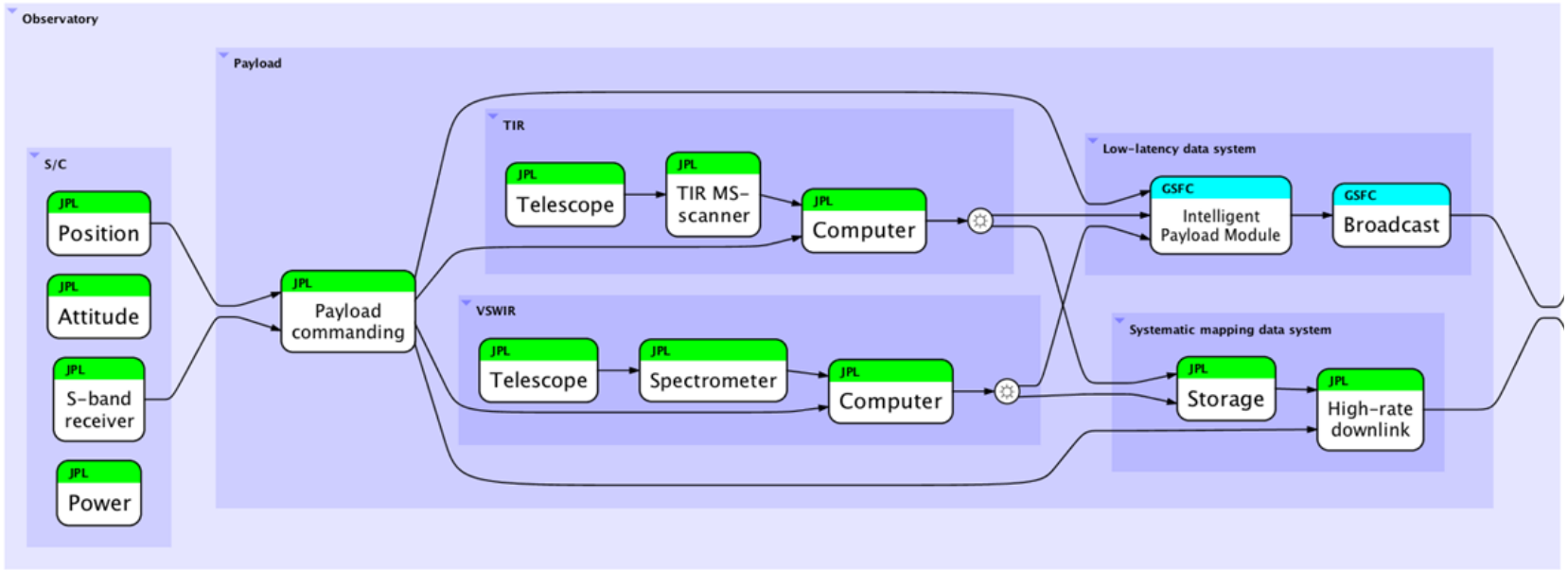
SV 5

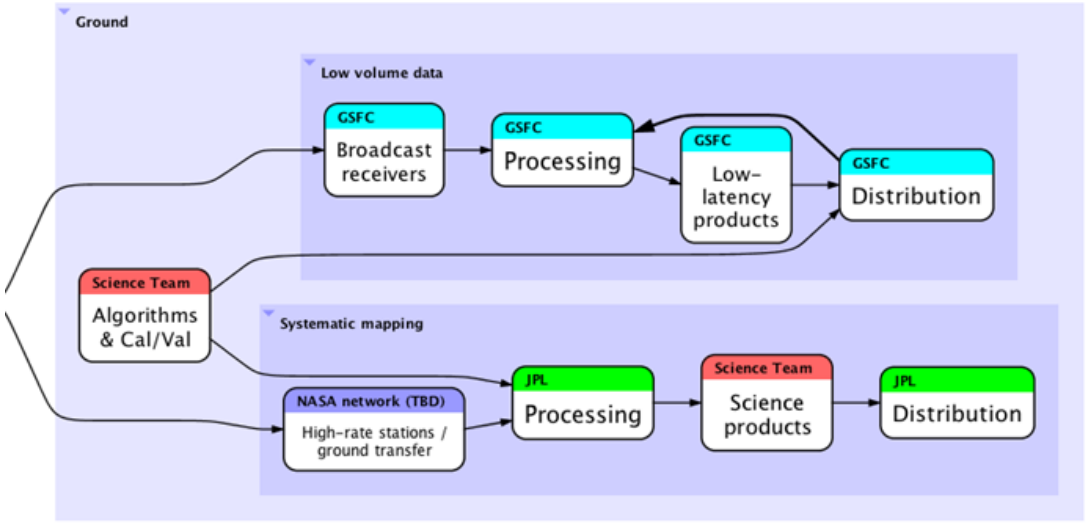
HyspIRI FY09 Study Team Plans

- What are the primary activities being done by whom? (see following charts)
  - Continued focused Mission and payload engineering [JPL, GSFC]
  - Complete HyspIRI whitepaper (Science Study Group) [JPL,GSFC]
  - Investment in incremental updates of current technology that are compelling for margin increase and risk reduction [JPL]
  - 2009 HyspIRI Science Workshop, 2nd Week of August
- What is the expected mission state at the end of FY09?
  - Ready for MCR in December 2009 [JPL lead with GSFC important roles]
  - Increased science and applications community awareness and buy-in
- How will the results of activities be documented?
  - Formal presentation and documents delivered to NASA HQ
    - Whitepaper, studies, traceability matrices, MCR documents, etc.
  - Paper and presentations at Science and Applications venues
  - Updates to the HyspIRI website
    - **http://hyspiri.jpl.nasa.gov**

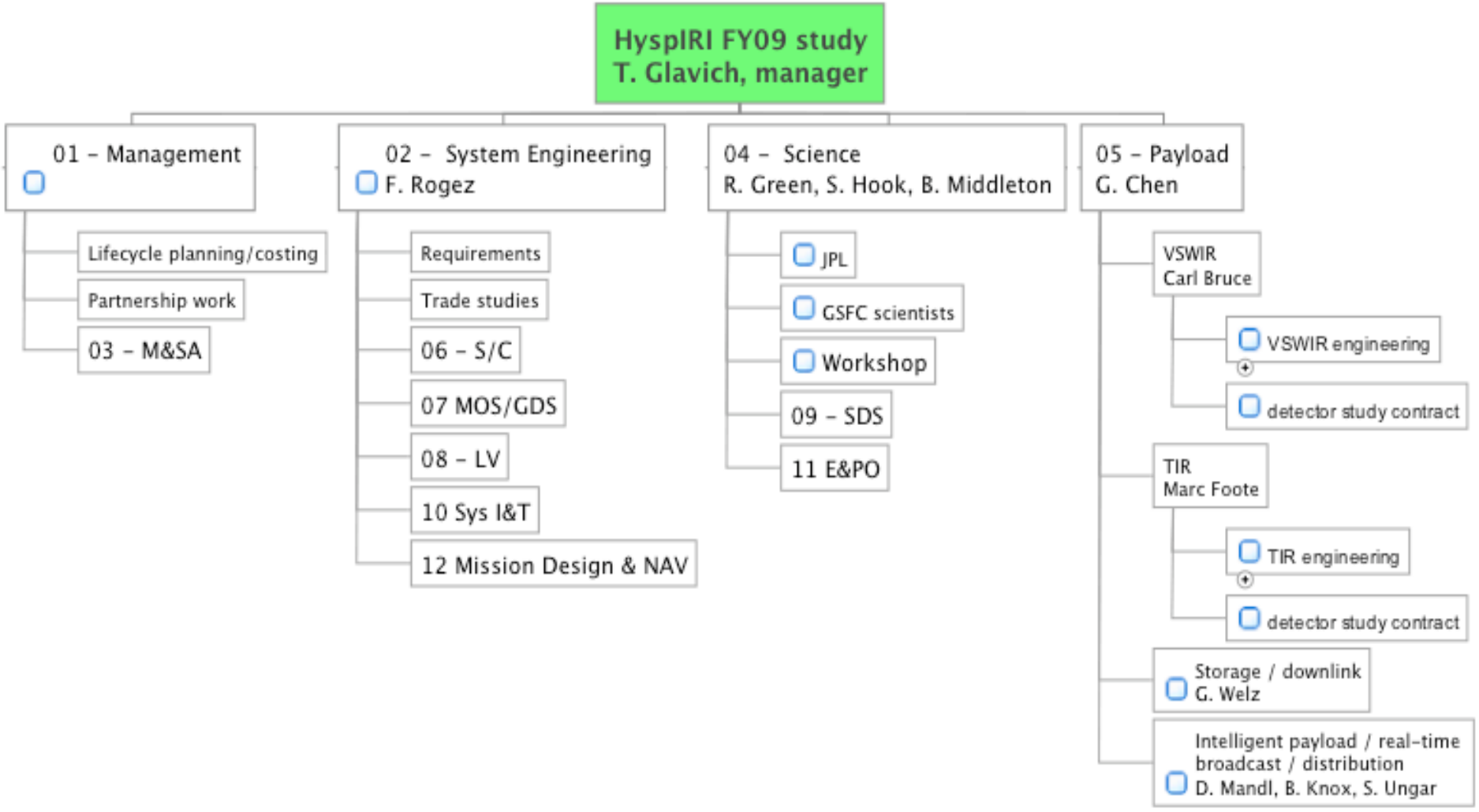
SV 5

HysplRI Current Study Roles and Flow





HyspIRI FY09 Study Architecture



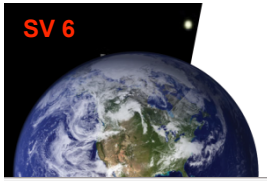


Chart 6: Study FY08 - FY09 schedule

Title	Expected Start	Expected End
Science workshop (3days)	10/21/08	10/21/08
HQ discussion	12/4/08	12/4/08
DS Symposium and TeamX results	2/11/09	2/11/09
Published workshop whitepaper	3/1/09	3/1/09
proposed draft L1 req	5/25/09	5/25/09
▷ New tech status report	7/20/09	7/20/09
2009 Science workshop	8/10/09	8/10/09
Mission Concept Review	12/18/09	12/18/09
Key Decision Point A	2/18/10	2/18/10
Launch	3/18/14	3/18/14
▼ **FY09 Mission Concept refinement**	10/1/08	11/20/09
▼ **Science**	10/1/08	10/1/09
▼ **Science refinement**	11/21/08	5/1/09
▷ Questions and STM	11/21/08	3/1/09
▷ Define science data products	3/1/09	5/1/09
2009 science workshop preparation	5/5/09	8/5/09
▷ Science analyssis and modeling	10/1/08	10/1/09
▼ **Mission work**	2/2/09	10/17/09
▼ **Propose draft L1 req**	2/2/09	5/25/09
Strawman	2/2/09	3/2/09
Baseline mission	3/2/09	3/30/09
Minimum mission	3/30/09	5/25/09
▼ **Mission refinment**	3/30/09	10/17/09
Early trade studies	3/30/09	6/22/09
Update driving L2 mission req	6/22/09	7/20/09
Update driving L3 S/C req	7/20/09	8/17/09
S/C RFI	8/17/09	10/17/09
▶ **TIR**	11/21/08	11/20/09
▶ **VSWIR**	11/21/08	11/20/09
▶ **On-board data storage and downlink**	12/4/08	9/20/09
▶ **Intelligent payload & broadcast**	12/4/08	9/20/09
▶ **non-NASA coordination**	10/21/08	11/20/09
▼ **pre-A project work**	11/21/08	2/18/10
Project organization	11/21/08	1/21/09
Define baseline implementation	3/1/09	7/1/09
Reference mission defined	7/20/09	7/20/09
Project lifetime planning	7/20/09	11/20/09
Phase A planning	7/20/09	11/20/09
Define technology infusion approach	7/20/09	8/31/09
MCR ready	11/20/09	11/20/09
Margin	11/20/09	12/18/09

SV 7

HyspIRI Study Issues and Challenges (1)

- What are the drivers to reaching KDP-A?
  - Draft level 1 science requirements (in process)
  - Baseline mission concept (complete w/ongoing risk reduction & margin increase)
  - Draft Formulation authorization document
  - Partnership evaluations (in process)
  - Technology readiness level assessments (baseline complete)
  - Baseline operations concept (baseline complete)

- What are you focusing your energy on?
  - Complete HyspIRI whitepaper (Science Study Group) [JPL,GSFC]
  - Investment in incremental updates of current technology that are compelling for margin increase and risk reduction [JPL]
  - Continue to iterate with science community on requirements definition
  - Preparation for readiness for MCR in Dec 2009 [JPL lead with GSFC]
  - Provide Science Study Group with antecedent measurements for algorithm development through existing and newly acquired airborne data, subject to additional funding.
  - 2009 HyspIRI Science Workshop, 2nd Week of August

- What cross mission activities are you concerned about but can't afford to deal with?
  - We have costed the 740 Mbps dual polarization downlink. However we believe this may be a common infrastructure need and cost savings are possible with a community solution.

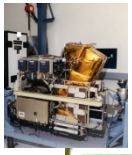
SV 7

HyspIRI Study Issues and Challenges (2)

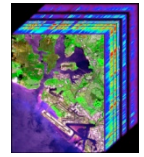
- What issues are too big for your group?
  - We would prefer an across-projects downlink solution.
  - We need support in developing partnership opportunities.
  - Across Decadal Survey data distribution system

- Are there technology readiness issues that are driving mission readiness?
  - There are no new technology issues.
  - **We are asking for a $780K augmentation spread across FY09-10 to pursue updates of existing detector technology to increase margin and reduce risk for both HyspIRI instruments.**

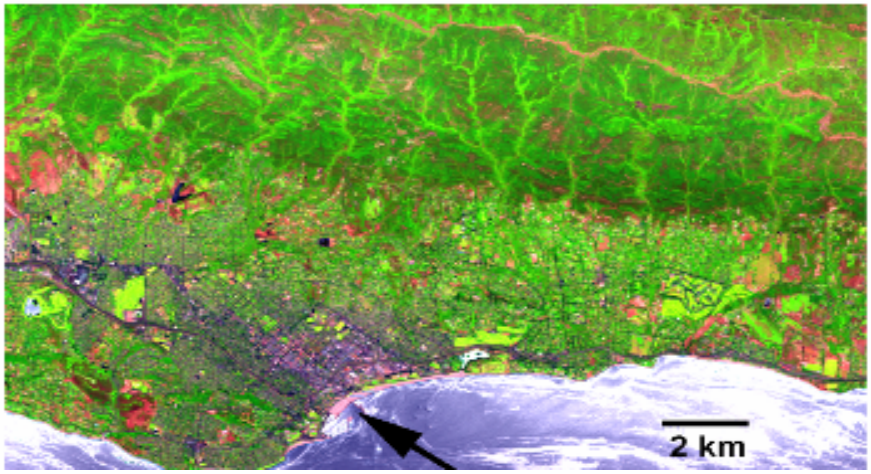
- What is the preferred approach for Science Development teams?
  - NASA Center directed leadership plus broadly competed team memberships.
  - To include Science Development expertise spanning the VSWIR, TIR, as well as Combined science and applications objectives



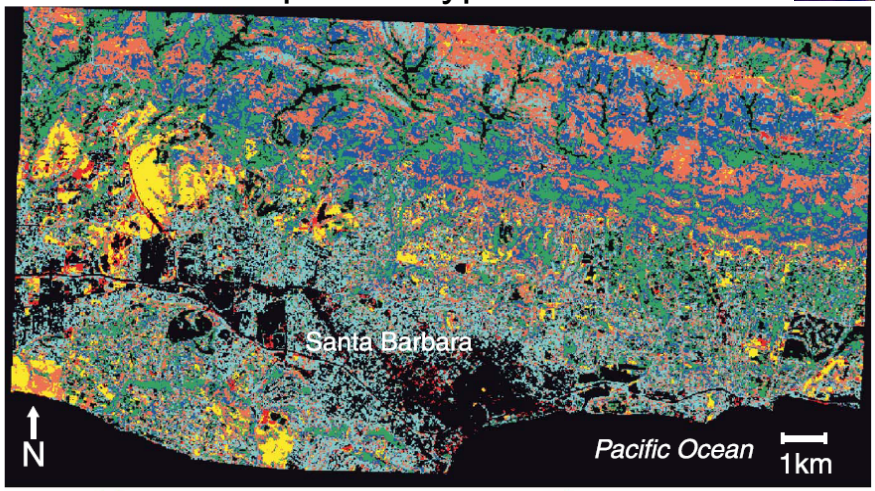
AVIRIS HyspIRI Science Measurement Heritage



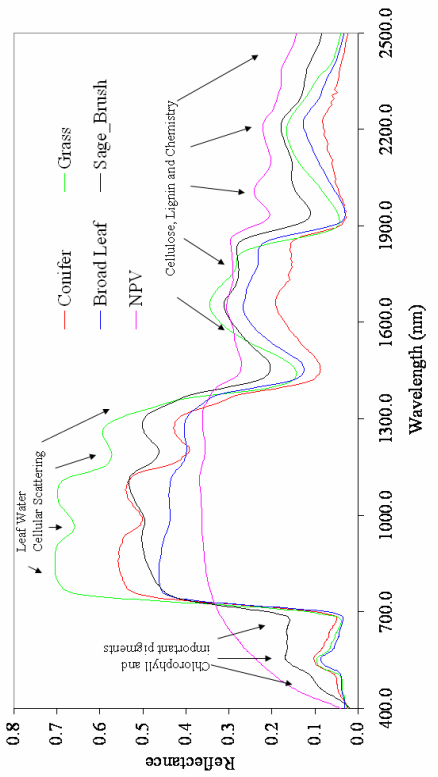
Dar Roberts, et al, UCSB

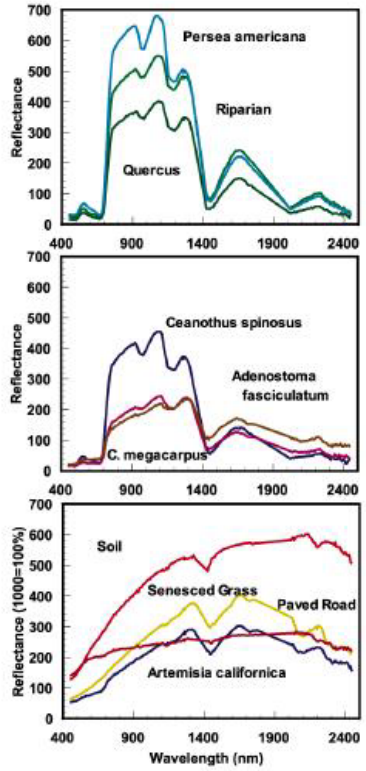


MESMA Species Type 90% accurate

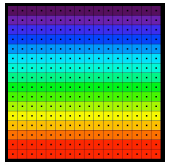


One science example based in spectroscopy



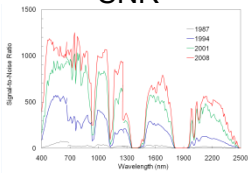


Uniformity

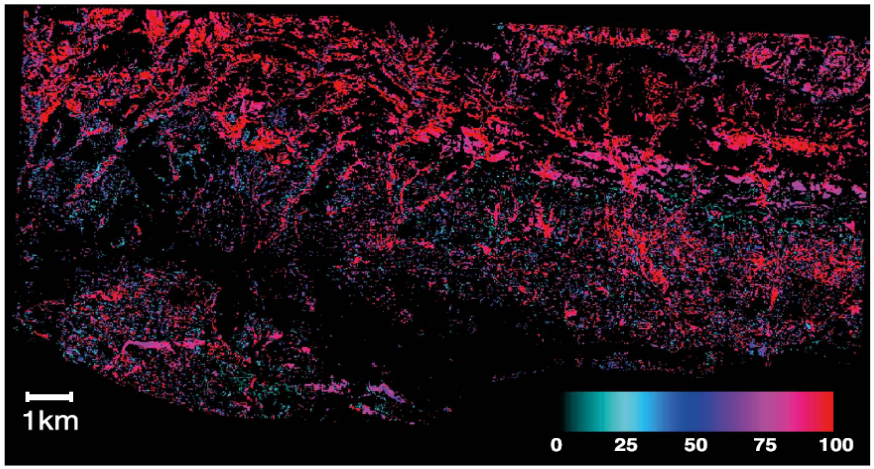


Adenostoma fasciculatum
Ceanothus megacarpus
Arctostaphylos spp.
Quercus agrifolia
Grass
Soil

SNR



Species Fractional Cover



Contribution: More than 500 Journal article reference AVIRIS in the title or abstract

Heritage: EO-1 Hyperion Op's/Analysis (3)

addresses a broad range of issues and world-wide sites

Forests

Canada

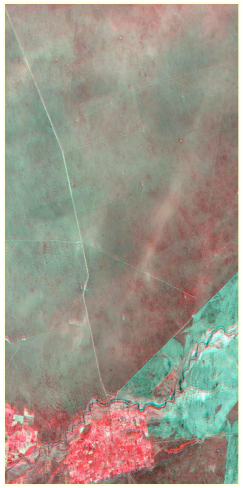
Agriculture

Australia

Minerals

United States

Grasslands



Argentina

Glaciers

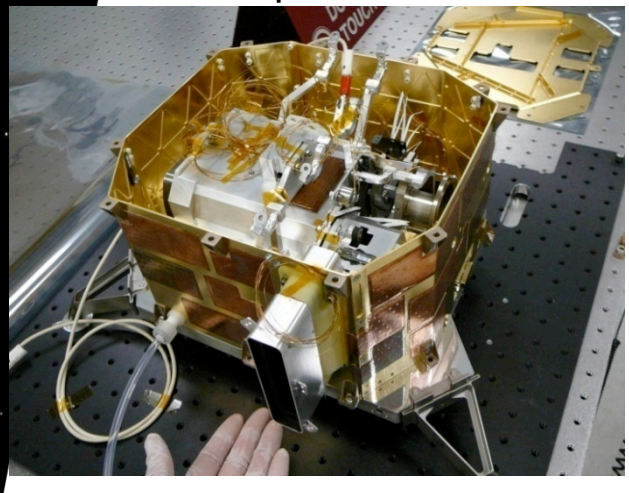
Antarctica

Deserts

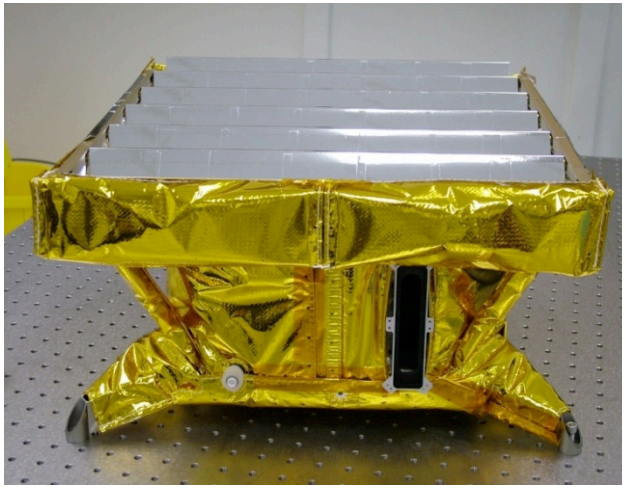
Sahara

Heritage: NASA Moon Mineralogy Mapper (1)

M3 Spectrometer

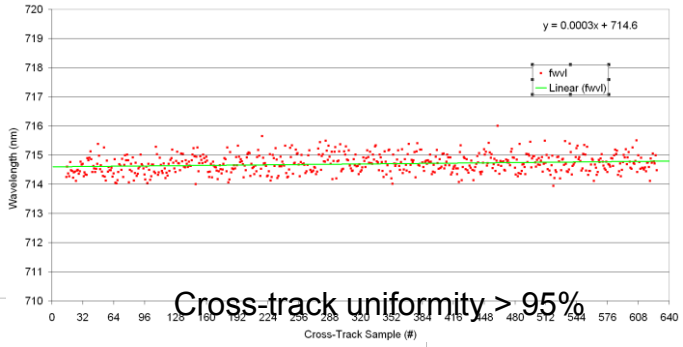


Mass 8 kg, Power 15 Watts

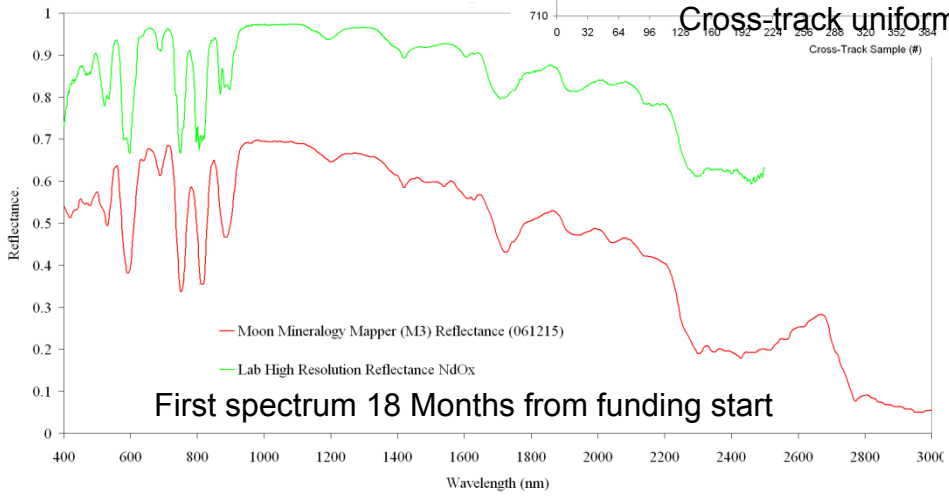


Passed Preship review 3 May 2007

- Mouroulis Offner Design (HyspIRI)
- Convex e-beam grating (HyspIRI)
- 6604a MCT full range detector array, multiplexor & signal chain (HyspIRI)
- Uniform slit (HyspIRI)
- 0.5 micron adjustment mounts lockable for flight
- Aligned to 95% cross-track uniformity (HyspIRI)
- Aligned to 95% spectral IFOV uniformity (HyspIRI)
- Meets high SNR requirements (HyspIRI)
- Passive radiator (HyspIRI)



Cross-track uniformity > 95%

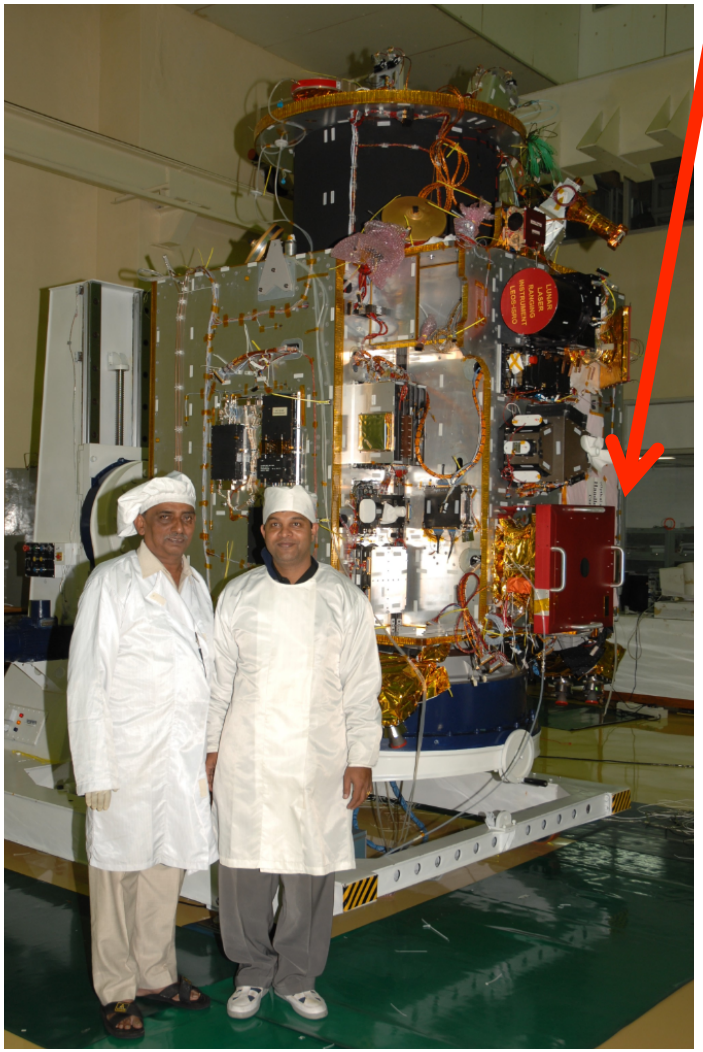


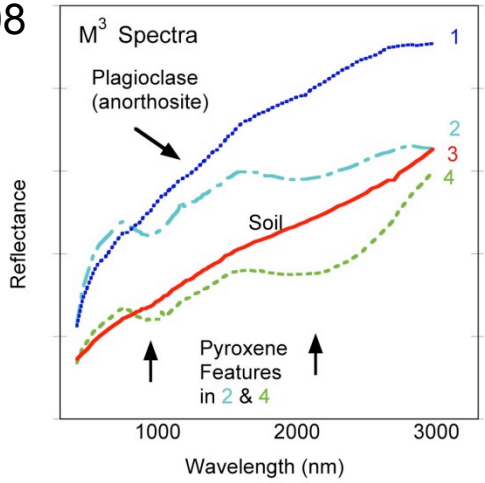
First spectrum 18 Months from funding start

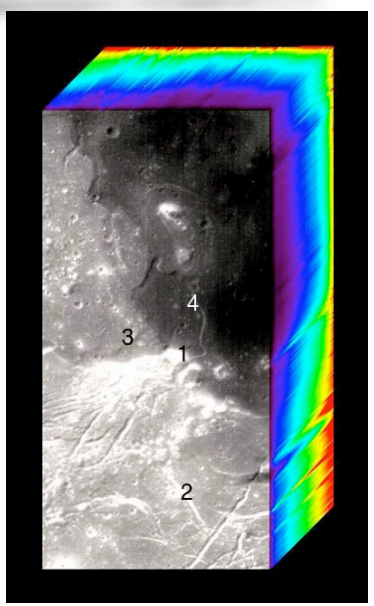
Heritage: M3 NASA Imaging Spectrometer (2)

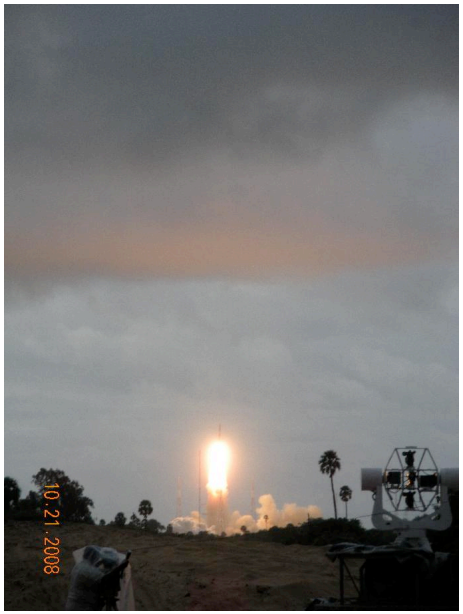
M3 Installed on spacecraft, Launched 22 Oct 2008

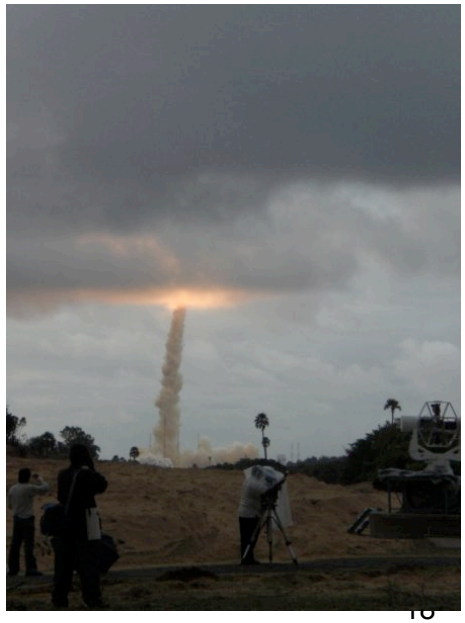
- http://Isro.gov.in, First light 19 Nov 2008











Discussion

Visible ShortWave InfraRed (VSWIR) Imaging Spectrometer

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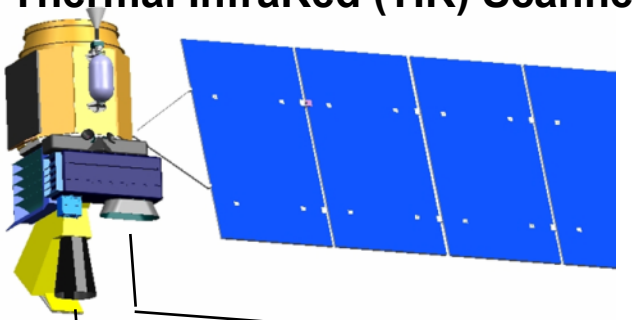
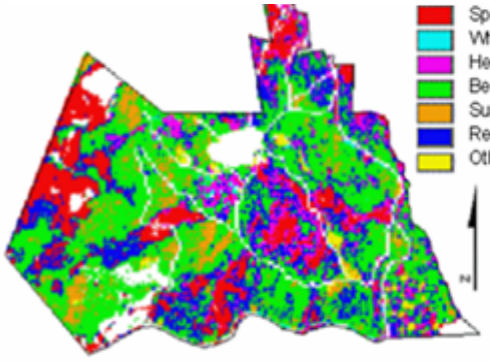
Multispectral Thermal InfraRed (TIR) Scanner

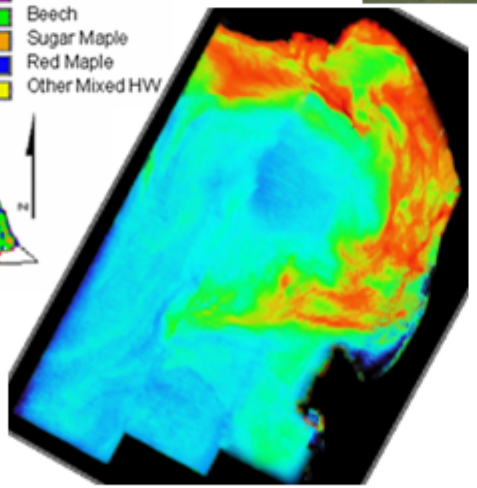


VSWIR: Plant Physiology and Function Types (PPFT)

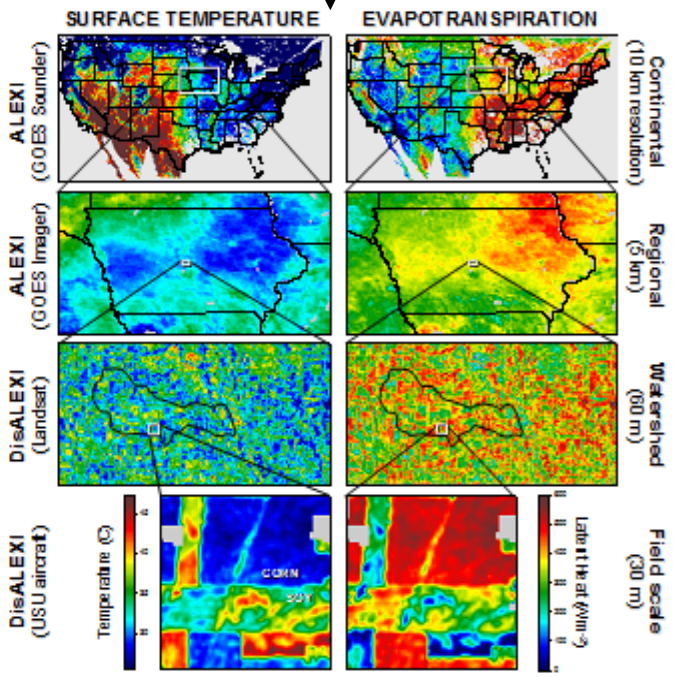
Multispectral TIR Scanner

Map of dominant tree species, Bartlett Forest, NH





Red tide algal bloom in Monterey Bay, CA



HypsIRI Back Up

HyspIRI Baseline Data Estimates

- Duty-cycle and data rates:
  - Duty cycle based on target masks
    - Full swath width acquisition baselined
    - Partial swath acquisition could reduce data volume
  - Includes illumination constraints (VSWIR)
  - Includes compression (TIR: 2x, VSWIR: 3x)
  - Includes overhead
  - Continuous averaged data-rate: 65 Mbps
- Data volume:
  - 372 Gb / orbit
  - 5.5 Tb / day

	VSWIR	TIR
rate (Mbps)	288.5	59.2
duty_cycle ratio	0.148	0.400
effective rate	42.700	23.672
overhead	10%	10%
avg rate w/ ovrhd	46.970	26.039
Obstruction ratio	0.2	0
After screening	37.576	26.039

WorldView-1: 331 Gb/orbit
DESDynI: 352 Gb/orbit

HyspIRI data-set is comparable to existing commercial and other future NASA missions.

2007 HyspIRI Science Working Groups

2007 HsypIRI PPFT Science Study Group:

- Concept Study Lead: **Francois Rogez** /JPL
- NASA Center Science Leads: **Rob Green** /JPL, **Steve Ungar** /GSFC & **Robert Knox** /GSFC
- Science Working Group: Leads: **Greg Asner** /Carnegie, **Frank Muller-Karger** /USF; Members: **Paul Bissett** /FERI, **Alex Chekalyuk** /Columbia, **Heidi Dierssen** /Uconn, **John Gamon** /CalState LA, **Simon Hook** /JPL, **Gerhard Meister** /GSFC, **Betsy Middleton** /GSFC, **Scott Ollinger** /UNH, **Dar Roberts** /UCSB, **Dave Siegel** /UCSB, **Phil Townsend** /U WI, **Sassan Saatchi** /JPL, **Susan Ustin** /UC Davis
-NASA HQ Science POC: **Woody Turner**, alt.: **Diane Wickland**, **Paula Bontempi** and **Bill Emanuel**

2007 HsypIRI TIR Science Study Group:

- Mission Concept Study Lead: **Tom Pagano, Francois Rogez** /JPL
- NASA Center Science Lead: **Simon Hook** /JPL
- Science Working Group: **Mike Abrams** /JPL (Hazards), **Martha Anderson** /USDA (Hydrological studies), **Wendy Calvin** /UNR (Geothermal), **James Crowley** /USGS (Mineral mapping), **Mariana Eneva** / ImageAir (Earthquakes/geothermal), **Luke Flynn** /U Hawaii (Volcanoes), **Louis Giglio** /SSAI (Fires), **Fred Kruse** /Horizon GeoImaging (Mineral mapping) , **Dimitar Ousounov** /GSFC (Earthquakes), Anupma Prakash/UAF (Volcanoes, Fires, Plumes), Dale Quattrochi/MSFC (Urban heat islands) , Vince Realmuto/JPL (Volcanic gases), David Roy/SDSU (Fires), Paul Silver-Carnegie Institution (Earthquakes)
- NASA HQ Science POC: **John LaBrecque, Diane Wickland**

2008 HsyplRI Science Study Group

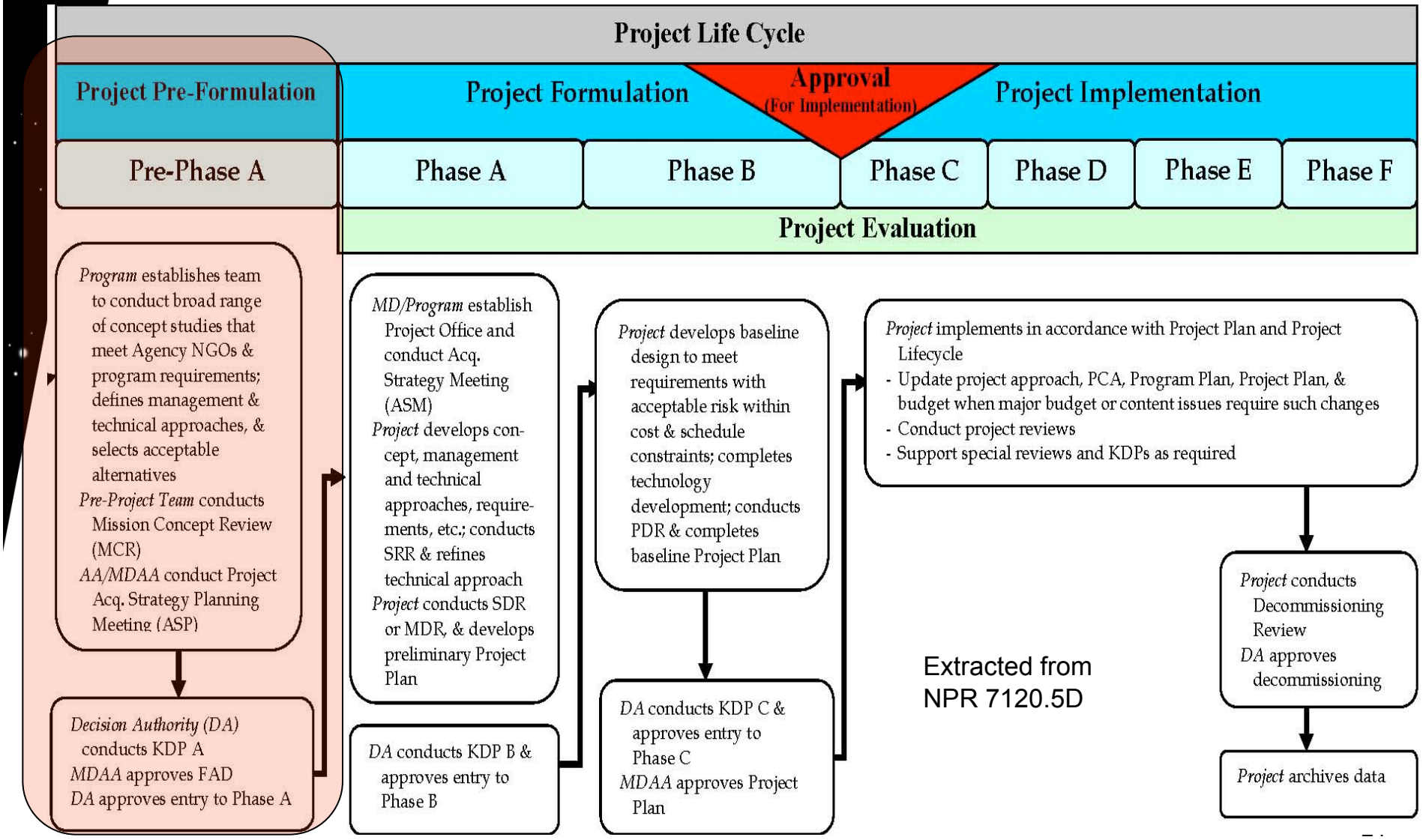
-Concept Study Lead: **Francois Rogez** /JPL

-NASA Center Science Leads: **Rob Green** /JPL, **Simon Hook**/ JPL, **Steve Ungar** /UMD & **Betsy Middleton**/GSFC

Science Study Group: **Mike Abrams,** JPL; **Rick Allen,** UID; **Martha Anderson,** USDA; **Greg Asner,** Stanford; **Bryan Bailey,** USGS EROS; **Paul Bissett,** FERI; **Alex Chekalyuk,** Lamont-Doherty**; James Crowley,** USGS; **Ivan Csiszar,** NOAA; **Heidi Dierssen**, U. Conn.; **Friedmann Freund**, Ames; **John Gamon**, UA; **Louis Giglio,** UMD; **Greg Glass,** JHU; **Robert Green,** JPL; **Simon Hook,** JPL; **James Irons,** GSFC; **Bob Knox,** GSFC; **John "Lyle" Mars,** USGS; **David Meyer,** USGS-EROS; **Betsy Middleton,** GSFC; **Peter Minnett,** U. Miami; **Frank Muller Karger,** Univ. Massachusetts Dartmouth; **Scott Ollinger**, UNH ; **Anupma Prakash,** UAF; **Dale Quattrochi,** MSFC; **Vince Realmuto,** JPL; **Dar Roberts,** UCSB; **Dave Siegel,** UCSB**; Phil Townsend,** University of Wisconsin; **Kevin Turpie,** GSFC; **Steve Ungar,** GSFC; **Susan Ustin,** UCD ; **Rob Wright** UHI

- NASA: **Woody Turner** & **John LaBrecque/ Lead,** with Diane Wickland, Paula Bontempi and Bill Emanuel

HysplRI Baseline Flight Project Life Cycle



Extracted from
NPR 7120.5D

HyspIRI Baseline Mission Requirements for Pre-Phase A

Scope of Major Pre-Phase A Activities:

Headquarters

- Approve a Formulation Authorization Document
- Develop DRAFT Level 1 Requirements
- Conduct Acquisition Strategy Planning Meeting

Technical Activities:

- Develop and document preliminary mission concepts
- Conduct internal Reviews
- Conduct Mission Concept Review Project Planning, Costing and Scheduling
- Develop and document a DRAFT Integrated Baseline, including:
  - *High level WBS*
  - *Assessment of Technology Readiness Levels*
  - *Assessment of Infrastructure and Workforce needs*
  - *Identification of potential partnerships*
  - *Identification of conceptual acquisition strategies for proposed major procurements*

KDP Readiness

- Obtain KDP A Readiness products
- Approval through the governing PMC

Areas the Science Community must work:

- Development of DRAFT Level 1 Science Requirements
- Support development of preliminary mission concepts
- Support the assessment of Technical Readiness Levels
- Identify potential partnerships

HyspIRI Baseline
Key Pre-Phase A Questions

- What science MUST this mission achieve?
  - *What specific measurements?*
  - *To what accuracy?*
  - *What are the required data products?*

Should be resolved ~ 12 months prior to KDP A

- What mission parameters can achieve the science?
  - *What orbit (inclination/altitude)?*
  - *Which instruments?*
  - *What is the baseline mission duration?*
- How can NASA achieve these measurements?
  - *Are there other missions required/desired to achieve the science?*
  - *Who can NASA partner with to achieve this mission?*

Should be resolved ~ 6 months prior to KDP A

HysplRI Baseline Science Measurements

Visible ShortWave InfraRed (VSWIR) Imaging Spectrometer

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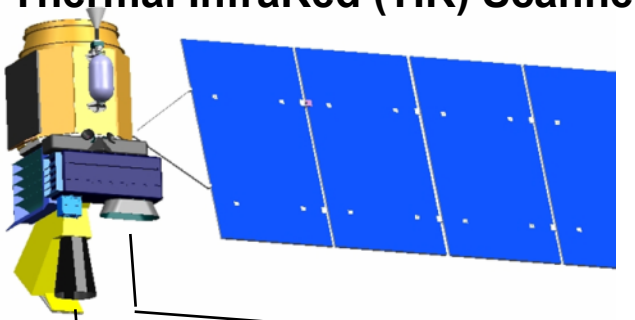
Multispectral Thermal InfraRed (TIR) Scanner



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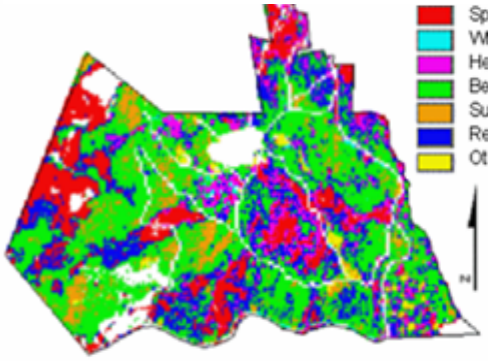

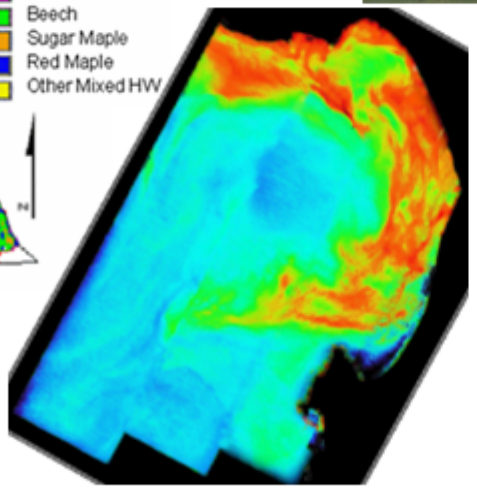

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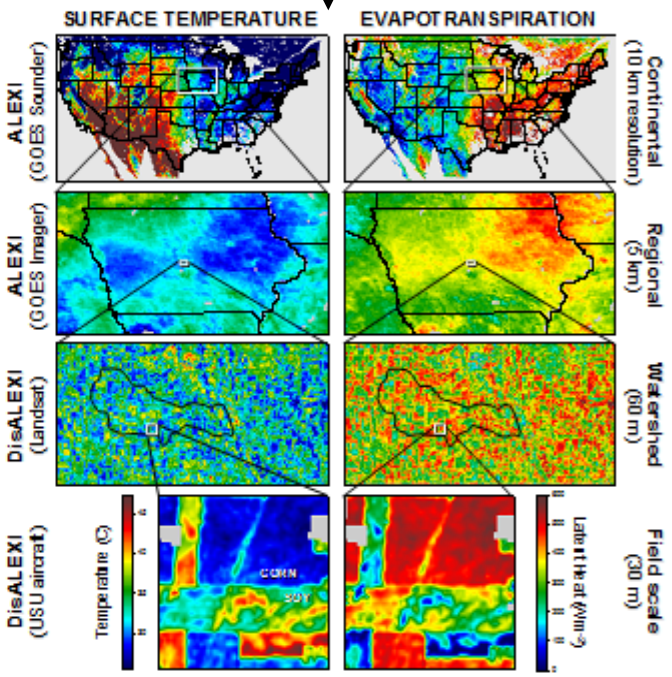
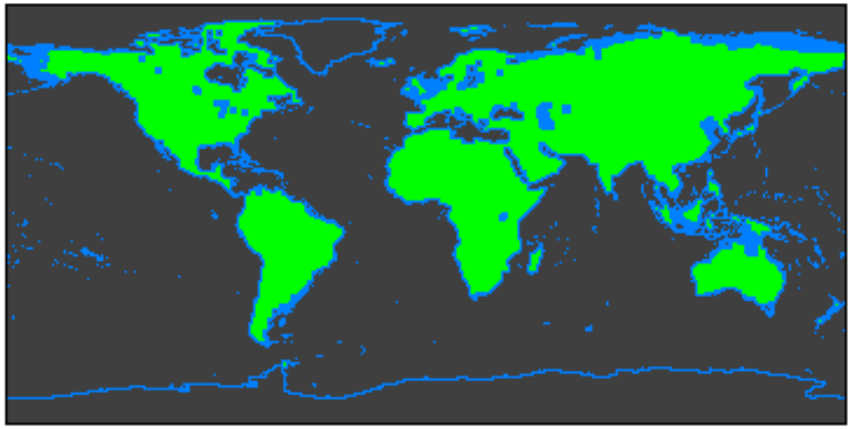


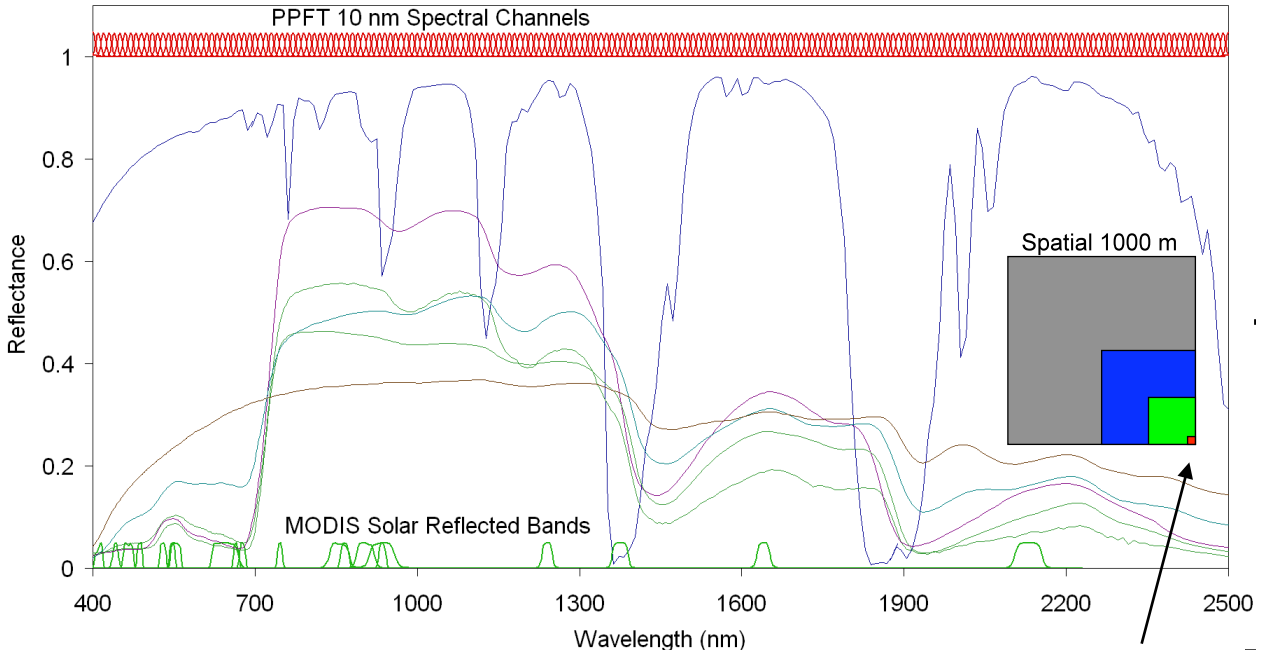
VSWIR

HyspIRI VSWIR Science Measurements



- Measure the **global** land and coastal/shallow water (> 50m).
- 19 day equatorial revisit to generate seasonal and annual products.

- Measure the molecular absorption and constituent scattering signatures in the spectral range from 380 to 2500 nm at 10 nm, and at 60 m spatial sampling.



HysplRI VSWIR
Science Measurement Characteristics

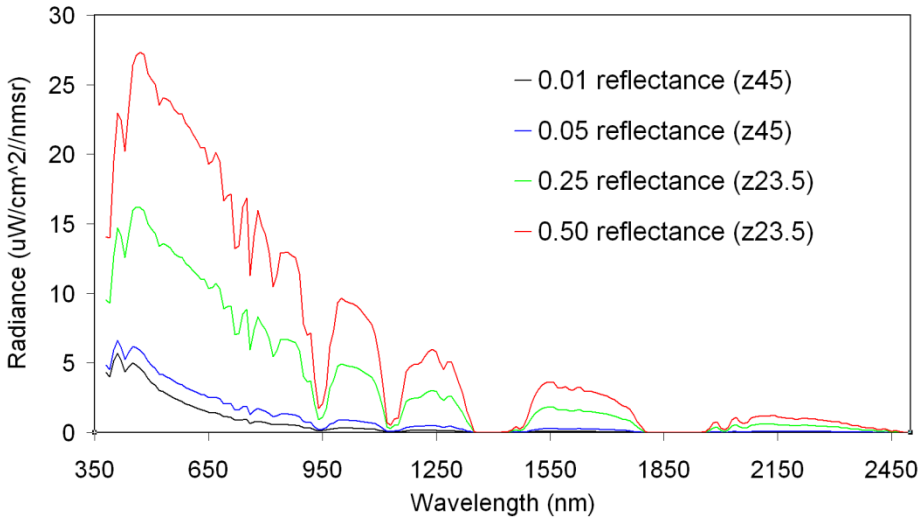
Spectral	
Range	380 to 2500 nm in the solar reflected spectrum
Sampling	<= 10 nm {uniform over range}
Response	<= 10 nm (full-width-at-half-maximum) {uniform over range}
Accuracy	<0.5 nm
Radiometric	
Range & Sampling	0 to 1.5 X max benchmark radiance, 14 bits measured
Accuracy stability	>95% absolute radiometric, 98% on-orbit reflectance, 99.5%
Precision (SNR)	See spectral plots at benchmark radiances
Linearity	>99% characterized to 0.1 %
Polarization	<2% sensitivity, characterized to 0.5 %
Scattered Light	<1:200 characterized to 0.1%
Spatial	
Range or swath	>150 km
Cross-Track Samples	>2500
Sampling	<=60 m
Response	<=60 m sampling (FWHM)
Uniformity	
Spectral Cross-Track	>95% cross-track uniformity {<0.5 nm min-max over swath}
Spectral-IFOV-Variation	>95% spectral IFOV uniformity {<5% variation over spectral range}

HyspIRI VSWIR Science Measurements Characteristics

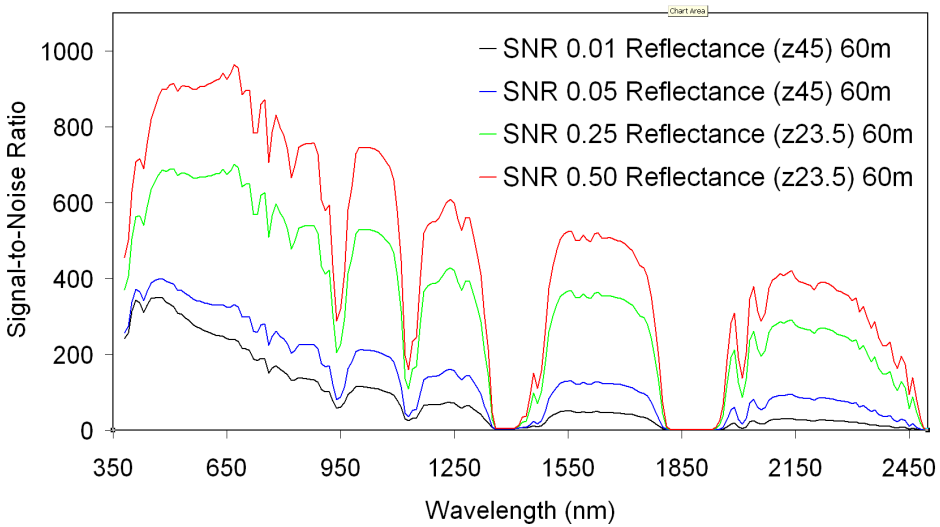
Temporal	
Orbit Crossing	11 am sun synchronous descending
Global Land Coast Repeat	19 days at equator
Rapid Response Revisit	3 days (cross-track pointing)
Sunglint Avoidance	
Cross Track Pointing	4 degrees in backscatter direction
OnOrbit Calibration	
Lunar View	1 per month {radiometric}
Solar Cover Views	1 per week {radiometric}
Surface Cal Experiments	6 per year {spectral & radiometric}
Data Collection	
Land Coverage	Land surface above sea level excluding ice sheets
Water Coverage	Coastal zone -50 m and shallower
Solar Elevation	20 degrees or greater
Open Ocean	Averaged to 1km spatial sampling
Compression	>=3.0 lossless

HysplRI VSWIR Science Measurements
Key SNR and Uniformity Requirements

Benchmark Radiances

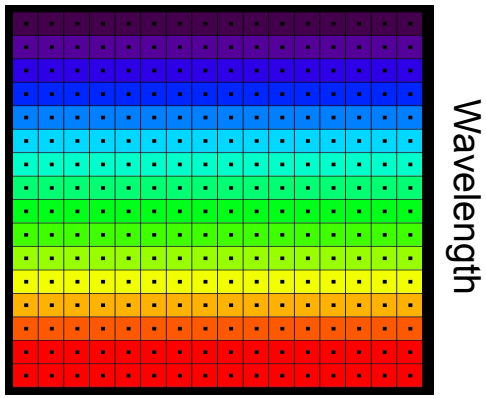


Required SNR



Uniformity Requirement

Cross Track Sample



Depiction

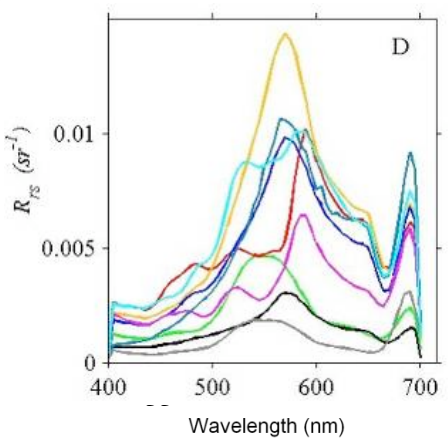
-Grids are the detectors
-dots are the IFOV centers
-Colors are the wavelengths

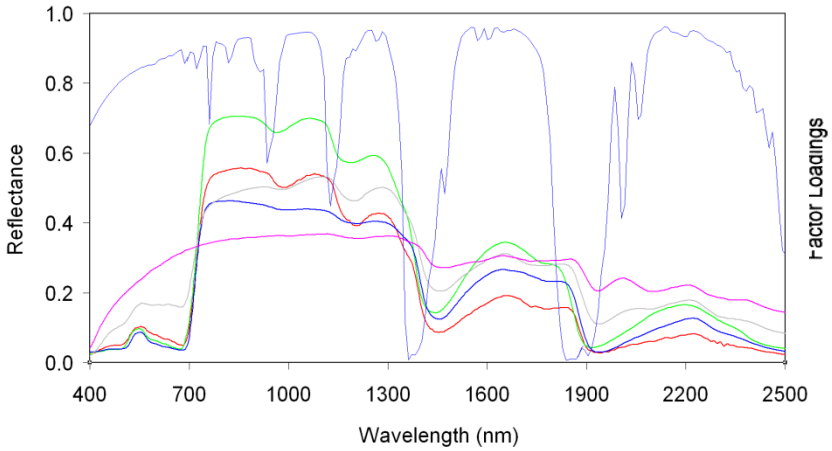
Requirement

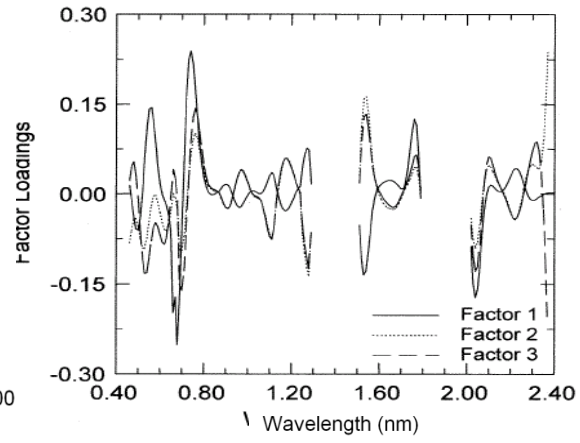
Spectral Cross-Track	>95% cross-track uniformity {<0.5 nm min-max over swath}
Spectral-IFOV-Variation	>95% spectral IFOV uniformity {<5% variation over spectral range}

The Need for Continuous Spectral Measurements

- Plant and phytoplankton functional types and species have biochemical and biophysical properties that are expressed as reflectance and absorption features spanning the spectral region from 380 to 2500 nm.
- Individual bands do not capture the diversity of biochemical and biophysical signatures of plant functional types or species.
- Changes in the chemical and physical configuration of ecosystems are often expressed as changes in the contiguous spectral signatures that relate directly to plant functional types, vegetation health, and species distribution.
- Important atmospheric correction information and calibration feedback is contained within the spectral measurement.

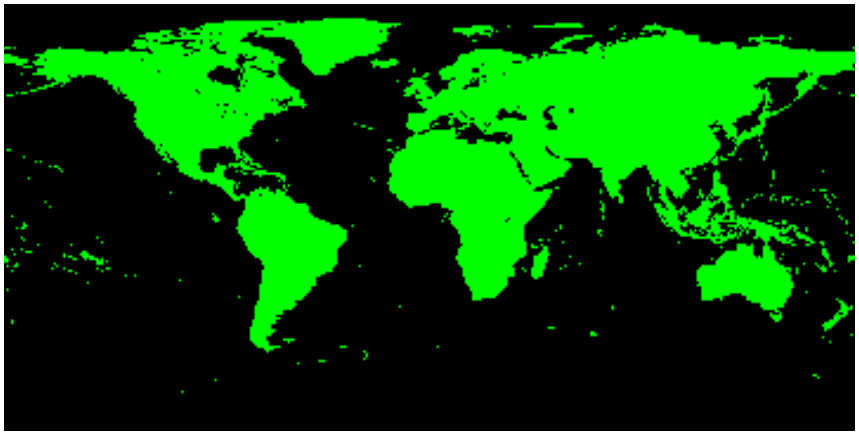






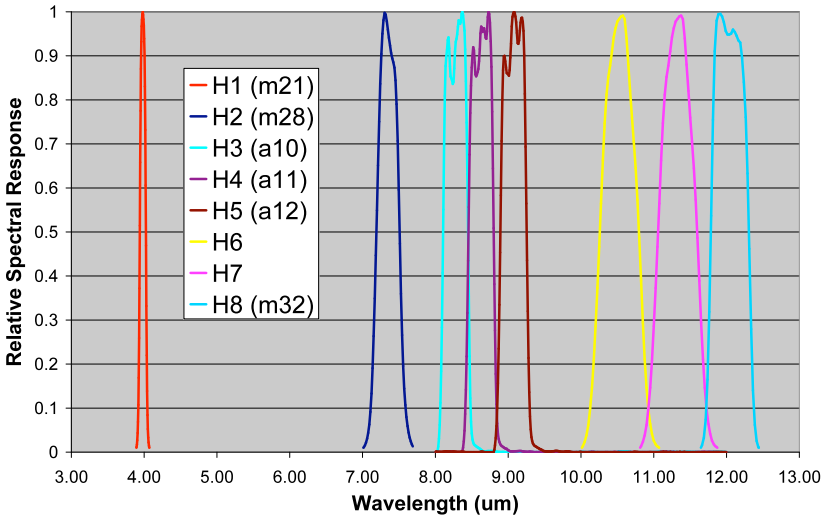
TIR

HysplRI Thermal Infrared Science Measurements



- Measure the land surface temperature and emissivity
- 5 day equatorial revisit to generate monthly, seasonal and annual products.
- 60 m spatial resolution

- 7 bands between 7.5-12 µm and 1 band between 3-5 µm
- 3-5 µm band saturates at 1400K
- 7.5-12 µm bands saturate at 400K



HysplRI TIR Science Measurements Summary Measurement Characteristics

Spectral		
	Bands (8)	3.98, 7.35, 8.28, 8.63, 9.07, 10.53, 11.33, 12.05 (μm)
	Bandwidth	0.084, 0.32, 0.34, 0.35, 0.36, 0.54, 0.54, 0.52 (μm)
	Accuracy	<0.01 μm
Radiometric		
	Range	Bands 2-8= 200K – 400K; Band 1= 1400K
	Resolution	< 0.05 K, Linear Quantization to 14 bits
	Accuracy	< 0.5 K 3-sigma at 250K
	Precision (NEdT)	< 0.2K
	Linearity	>99% characterized to 0.1 %
Spatial		
	IFOV	60 m
	MTF	>0.2 at FNy
	Scan Type	Whiskbroom
	Swath Width	600 km (±25.5° at 623 km altitude)

TIR Science Measurements Characteristics Continued

Temporal

Orbit Crossing	11 am sun synchronous descending
Global Land Repeat	5 days at equator

OnOrbit Calibration

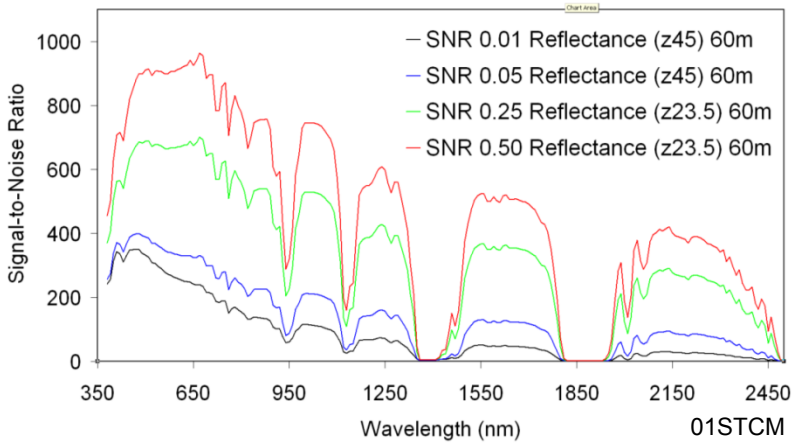
Lunar View	1 per month {radiometric}
Blackbody Views	1 per scan {radiometric}
Surface Cal Experiments	1 per month {radiometric}
Spectral Surface Cal Experiments	1 per year

Data Collection

Land Coverage	Land surface above sea level Day/Night Always-on
Downlink Stations	Svalbard and Fairbanks

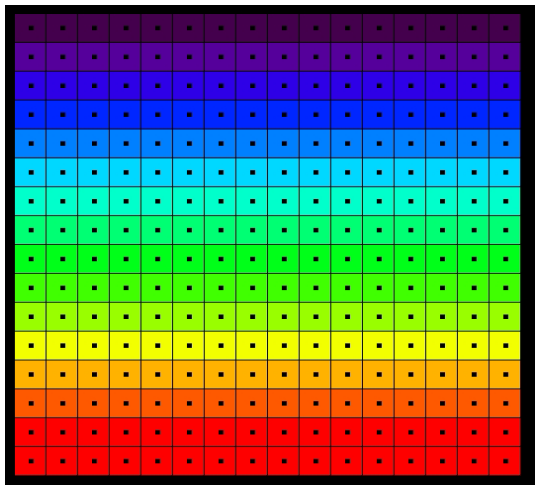
HyspIRI: Building on NASA Hyperion Technology Demonstration

SNR > 10X



01STCM B.36.1.1

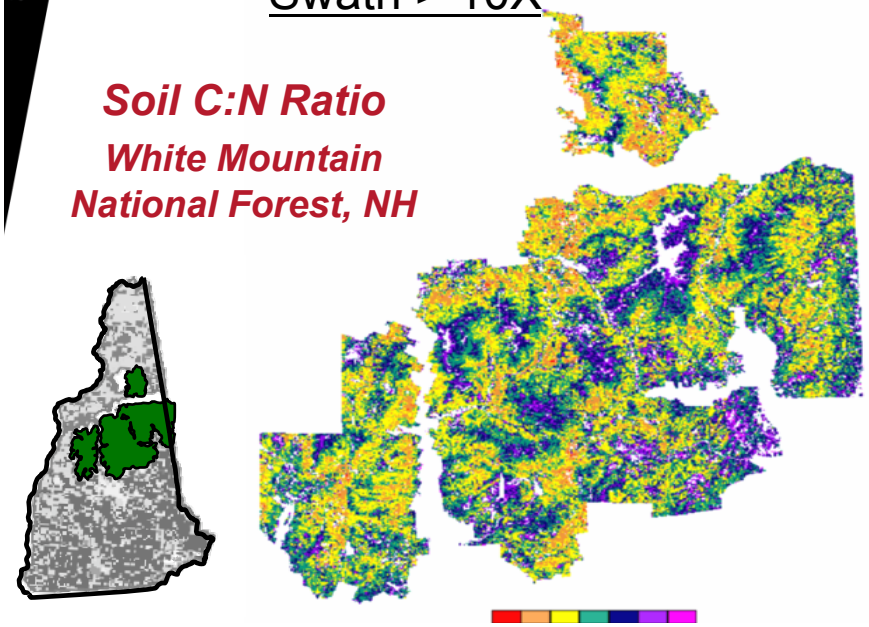
Uniformity > 10X



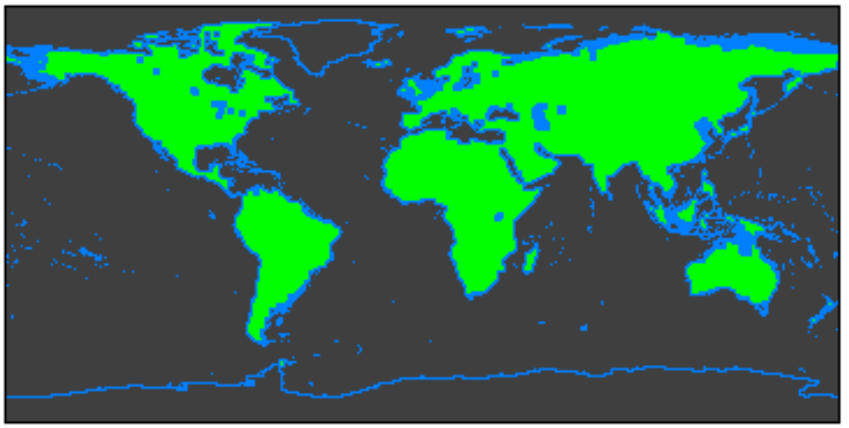
Swath > 10X

Soil C:N Ratio

White Mountain National Forest, NH



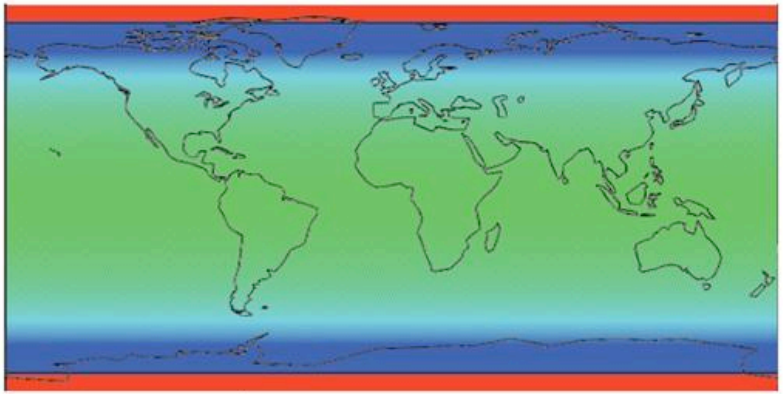
Global Coverage >> 10X



HysplRI Measurement Repeats

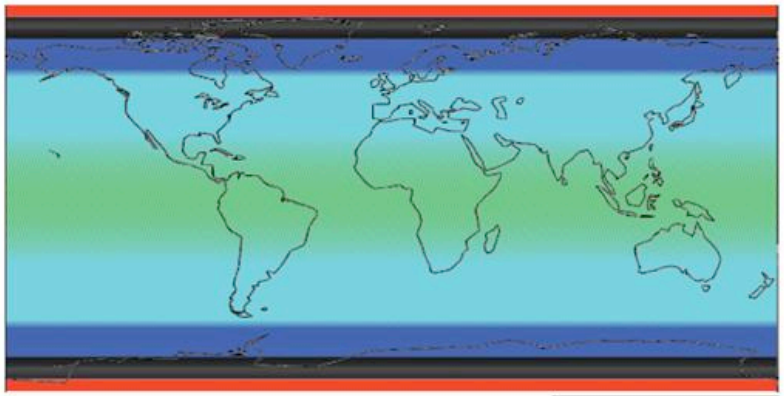
Geometrical Access in 19 days

Number of daytime VSWIR access (no nighttime)



0
1
2
>2 and <19
>=19

Number of daytime TIR access (nighttime is identical)



<4
4
>4 and <=8
>8 and <19
>=19

The above plots show the average gap between access to each location.
Effects of Sun illumination and clouds are not included.

The 626 km orbit is one of the few that also minimize the maximum temporal gaps between acquisitions.